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SEC: B

SEMESTER: 6th

Paper Hydraulic Engineering

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Dated 24/6/2020

Q.NO # 01

Solution: The pressure drop ΔP is expected to depend upon the gate opening the overall depth 'd', the velocity V, density and Viscosity μ VP,

h, d, V, ρ, μ.

Dimension:

ΔP	$ML^{-1}T^{-2}$
h	L
d	L
V	LT^{-1}
ρ	ML^{-3}
μ	$ML^{-1}T^{-1}$

Number of Variable $= n = 6$

Number of independent Dimension $= M = 3$ (M, L and T)

Number of Non-Dimensional group $n - m = 3$

→ Choose $M = 3$ scaling variable, geometric d:

Kinematic / Time - dependent (V) dynamic/mass dependent (ρ)

(2) 7866

From dimensionless group by non-dimensionalising the remaining variable : ΔP, h & μ

$\pi_1 = \Delta P d^a V^b \rho^c$

$M^0 L^0 T^0 = (ML^{-1}T^{-2}) (L)^a (LT^{-1})^b (ML^{-3})^c$

$= M^{1+c} L^{-1+a+b-3c} T^{-2-b}$

$M: 0 = 1+c \Rightarrow c = -1$

$T: 0 = -2-b \Rightarrow b = -2$

$L: 0 = -1+a+b-3c \Rightarrow a = 1+3c-b = 0$

$\rightarrow \pi_1 = \Delta P V^{-2} \rho^{-1} = \frac{\Delta P}{\rho V^2}$

Now $\pi_2 = \frac{h}{d}$ (By Inspection Since the length)

$\pi_3 = \mu d^a V^a \rho^c$

$M^0 L^0 T^0 = (ML^{-1}T^{-1})(L)^a (LT^{-1})^b (ML^{-3})^c$

$= M^{1+c} L^{-1+a+b-3c} T^{-1-b}$

$M: 0 = 1+c \Rightarrow c = -1$

$T: 0 = -1-b+0 \Rightarrow b -1$

L: $0 = -1 + a + b - 3c \Rightarrow a = 1 + 3c - b = -1$

$$\rightarrow \pi_3 = \mu d^{-1} V^{-1} \rho^{-1} = \frac{\mu}{\rho V d}$$

Recognition of the Reynolds number suggests that we replace π_3 by by $\pi_3' = (\pi_3)^{-1} = \frac{\rho V d}{\mu}$

Hence dimensional analysis yields.

i.e $\pi_1 = f(\pi_2, \pi_3')$

$$\frac{\Delta P}{\rho V^2} = f\left(\frac{h}{d}, \frac{\rho V d}{\mu}\right)$$

(a) Dynamic similarity requires that all non-dimensional groups be the same in model and prototype : i.e

$$\pi_1 = \left(\frac{\Delta P}{\rho V^2}\right)_p = \left(\frac{\Delta P}{\rho V^2}\right)_m$$

$$\pi_2 = \left(h/d\right)_n = \left(h/d\right)_m$$ (Similar shape i.e geometric similarity)

$$\pi_3' = \left(\frac{\rho V d}{\mu}\right)_p = \left(\frac{\rho V d}{\mu}\right)_m$$

From the last we have a velocity ratio

$$\frac{V_p}{V_m} = \frac{(\mu/\rho)_p \, d_m}{(\mu/\rho)_m \, d_p} = \frac{0.0021800}{1.0\times10^{-6}} \times \frac{1}{5} = 0.5$$

Thus:

$$V_m = \frac{V_p}{0.5} = \frac{3.0}{0.5} = 6 \ m/s$$

(b) The ratio of the quantities of flow is

$$\frac{Q_p}{Q_m} = \frac{(\text{Velocity}\times\text{Area})_p}{(\text{Velocity}\times\text{Area})_m} = \frac{V_p}{V_m}\left(\frac{d_p}{d_m}\right)^2 = 0.5 \times 10^2 = 12.5$$

(c) Finally for the ~~depression~~ pressure drop.

$$\Lambda_1 = \left(\frac{\Delta P}{\rho V^2}\right)_p = \left(\frac{\Delta P}{\rho V^2}\right)_m \Rightarrow \frac{(\Delta P)_p}{(\Delta P)_m} = \frac{\rho_p}{\rho_m}\left(\frac{V_p}{V_m}\right)^2$$

$$= \frac{800}{1000} \times 0.5^2 = 0.2$$

Thus $\Delta P_p = 0.2 \times \Delta P_m = 0.2 \times 60$

$$\Rightarrow \boxed{\Delta P_m = 12.0 \ KPa}$$

(5) 7866

QNO # 02

Solution:

$\because T = 786$, $\because G = 2.4$, $C_u = 0$

(1) $H_{limiting} = \dfrac{\sigma_{all}}{\gamma_w (G - C_u + 1)} = \dfrac{120 \times 786 \times 1000}{1000(2.4 - 0 + 1)}$

~~= 2783~~

$= 27741.176 m$

let $H_w = 24000 m$ Thus $27741.176 > H_w = 24000$

So it is low gravity dam.

(2) Top width "a"

Free Board $= 1.5 h_{wave} = 1.5 \times 24000$

$\boxed{F.B = 36000 m}$

Height of Dam $= H_D = H_w + F.B = 24000 + 36000$

$\boxed{H_D = 60000}$

$a = 14\%$ of H_D

$= 0.14 \times 60000 \Rightarrow \boxed{a = 8400 m}$

(3) Base with "b" (without offset

(i) For NO sliding criteria.

$$b' = \frac{H_w}{\mu G} = \frac{24000}{0.7 \times 2.4} = 14285.71$$

$$\boxed{b' \approx 14285.71 m}$$

(ii) For no tension Criteria.

$$b' = \frac{H_w}{\sqrt{G}} = \frac{24000}{\sqrt{2.4}} = 15491.93$$

$$\boxed{b' \approx 15491.93}$$

(4) Depth of vertical portion on U/s side.

$$h' = 2a\sqrt{G - C_u}$$

$$h' = 2 \times 8400 \sqrt{2.4 - 0}$$

$$h' = 26026.44 m$$

So $\boxed{h' = 26026.44 m}$

(5) Upstream off set $= \frac{a}{16} = \frac{8400}{16} = 525 m$

(6) Depth below the water level to the end of inclined portion in u/s

$$= 3.14\, a \sqrt{G}$$

$= 3.14 \times 8400 \sqrt{2.4}$

$= 40861.523 m$

(7) Total width of the base of the dam.

$$b = b' + \frac{a}{16}$$

$$= 15491.93 + \frac{8400}{16}$$

$$= 16016.93$$

(8) $\tan\phi = \frac{b'}{H} = \frac{15491.93}{24000}$

$$\theta = \tan^{-1}\left(\frac{15491.93}{24000}\right)$$

$$\boxed{\theta = 32.84^\circ}$$

(9) Depth of vertical portion on D/S

$$\tan\phi = \frac{a}{d'} = \frac{8400}{d'}$$

$$\left(\frac{15491.93}{24000}\right) d' = 8400$$

P.T.O

$$d' = \frac{8400 \times 24000}{15491.93}$$

$$\boxed{d' = 13013.22m}$$

Depth of vertical portion.

$$d = d' + FB$$

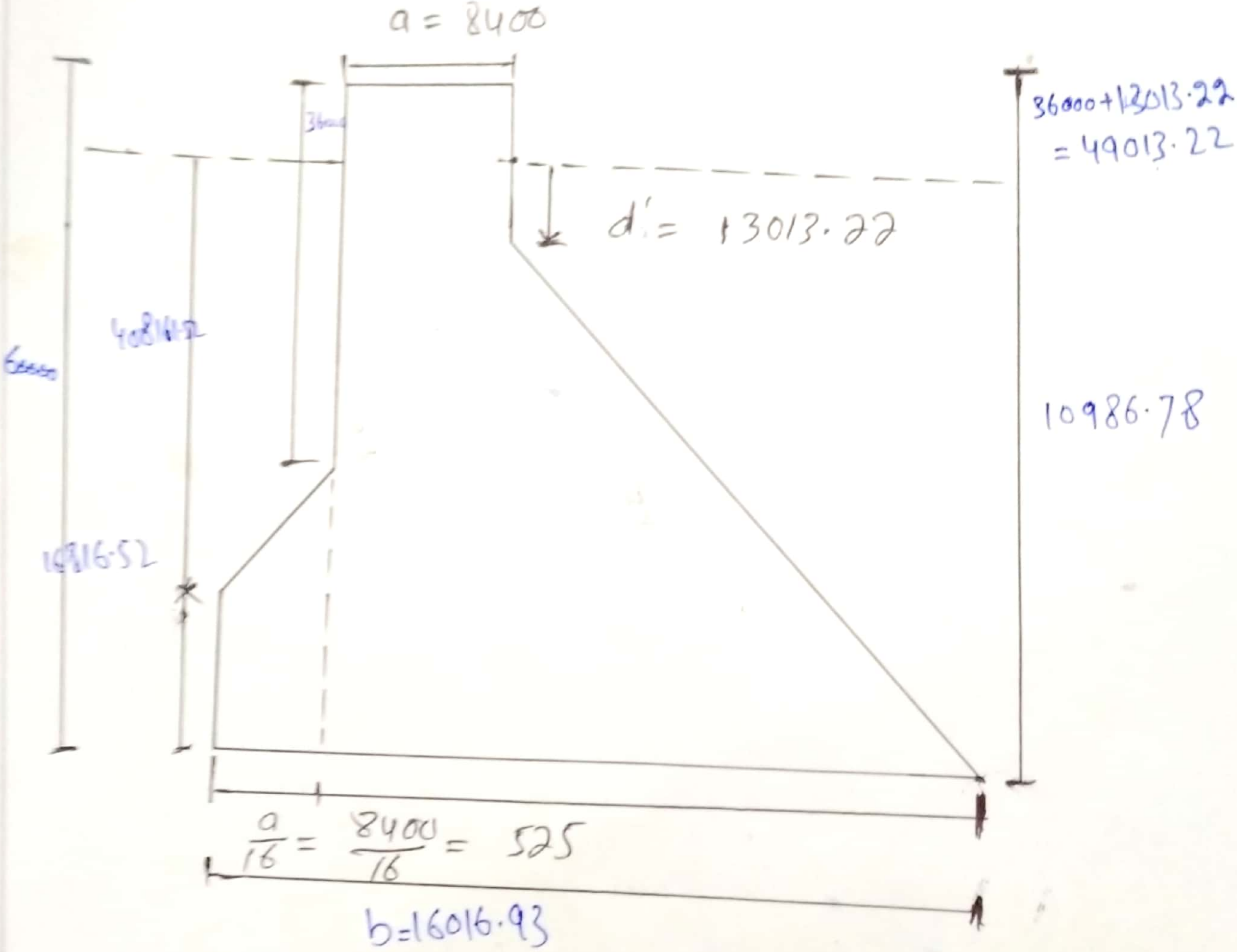
$$d = 13013.22 + 36000$$

$$\boxed{d = 49013.22\ m}$$

Diagram is Drawn ON NEXT PAGE.

P.T.O

(9) 7866



QN.O# 03

Dimensional Analysis:-

Analysis using the fact that physical quantities added to or equated with each other must be expressed interm of same functional same functional quantities (Such as mass, length, or Time.) For inference to be made about the relations b/w them.

* e.g Dimentional Analysis.

How many second are there in one day?

$$\frac{24\,hr}{1\,day}\;\frac{60\,min}{1\,hr}\;\frac{60\,s}{1\,min} = 86400\,s/day$$

SEMILITUDE AND DIMENSIONAL ANALYSIS:-

INTRODUCTION:

An understanding of the principles of similitude and dimentional analysis is essential for the successful outcomes of a program of experimental research, whether it involve fundamental study of fluid flow- The corelation of laboratory and field data or the laboratory design and Testing of a hydralic structure.

Similatitude principles are needed in answering the following modeling question.

* What is necessary to stimulate prototype condition with a model.?
* How do measure velocity, forces, stresses, Time period,
* Can the result from different experiment or models.

FRANCIS TURBINE:-

* A Francis Turbine Rotates in a closed Casing
* Its wheel has many curved

blades called runner vanes as many as 24

* Its shaft is vertical. The wheel of a Francis Turbine operate under water
* The guide vanes and stay vanes control the amount of water flowing into the Runner vannes.
* The runner is rotated mainly due to the weight or pressure of the flowing water.

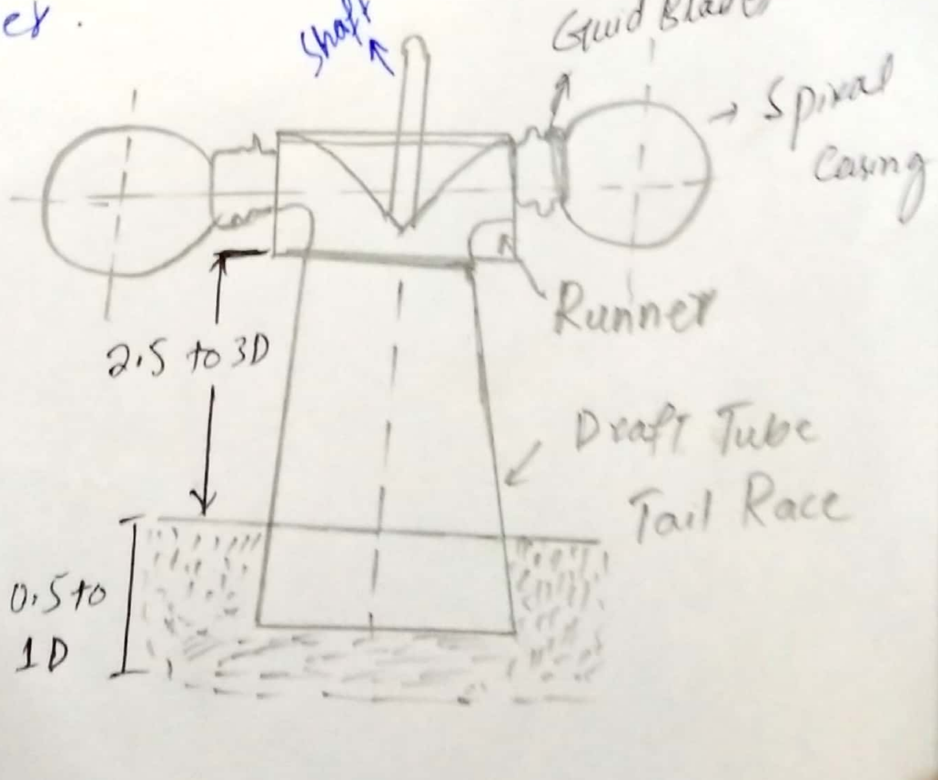


Diagram Francis Turbine.

QN.0 (4)

(i) Particle Diameters.

The particle size will influence the failure strength of hydrate bearing sediment. Large size particles will significantly enhance the failure, strength of sediments

(ii) Particle Density;

The effect of particle density on the sources, distribution and degradation of sedimentary organic carbon in the changiang Esturary and adjacent shelf.

(iii) Particle Concentration:.

When the suspended concentration of sediment increases, the settling velocity of each particles decreases due

due to the modification of the flow induced by previous particles.

(IV) Particle Shape.

Particle shape effects on packing density, stiffness, and strength natural and crushed sands

The size and shape of soil particles reflect the formation history of the grains.

(V) ~~Viscosi~~ Viscosity of water.

From the experimental study we can see that parameter such as temperature and pressure changes the magnitude of viscosity so the section of water having more temperature and pressure will fall objectively more due to increase the kinetic energy

(vi) Turbulence of water:-

Turbulence of water depends upon the different factors such as velocity. It will effect the fall velocity because of its zigzag motion thus the velocity varies at every point which is why it effect the fall velocity moreover increases in the K.E tends to effect the fall velocity compared with steady flow.

The END